Edward Hermon, Esq., M.P. for Preston	£1	1	0
Capt. J. Herschel, F.R.S., &c.	1	1	0
The Parish of Hoole	5	5	0
The Right Hon. Lord Houghton, F.R.S., &c.	1	1	0
William Huggins, Esq., D.C.L., LL.D., F.R.S., Foreign Secretary of the Royal Astronomical Society	1	1	0
Sir J. Kay-Shuttleworth, Bart.	1	1	0
William Lassell, Esq., F.R.S., &c.	1	1	0
Lord Lindsay, M.P., &c.	1	1	0
J. Norman Lockyer, Esq., F.R.S., &c.	1	1	0
The Right Rev. the Bishop of Manchester	1	1	0
Mrs. Charles Orme	1	1	0
Mrs. G. M. Patmore	1	1	0
William Pollard, Esq.	1	1	0
The Rev. Charles Pritchard, M.A., F.R.S., Savilian Professor of Astronomy in the University of Oxford	1	1	0
Richard A. Proctor, Esq., B.A., &c. &c.	1	1	0
A. Cowper Ranyard, Esq., M.A., Secretary to the Royal Astronomical Society	1	1	0
The Earl of Rosse, F.R.S., &c. &c.	1	1	0
Henry J. S. Smith, Esq., M.A., F.R.S., Savilian Professor of Geometry in the University of Oxford	1	1	0
F. Styles, Esq.	1	1	0

General Treasurer—Prof. ADAMS, the Observatory, Cambridge.

The Rev. R. Brickel, the Rectory, Hoole, Preston, Lancashire; Prof. Grant, the Observatory, Glasgow; Mrs. G. M. Patmore, 81, Avenue Road, N.W.; and A. Cowper Ranyard, Esq., 25, Old Square, Lincoln's Inn, W.C., have kindly promised to receive and acknowledge subscriptions.

FERTILISATION OF FLOWERS BY INSECTS *

VII.

Butterflies the most frequent visitors of Alpine flowers.

IN the following article I wish to recommend for further inquiry a subject of peculiar interest which, in the environs of the Ortler, in Tyrol, forced itself on my attention last summer, but which, during my short stay in the Alps (8—25 July), I had not time to investigate so thoroughly as it deserves. Whilst occupied, along with my son, in observing the Alpine flowers and their fertilisation by insects, we were struck with the very small number of Apidæ met with in higher Alpine (subnival) localities, and with the predominant part which butterflies play in this region in relation to the fertilisation of flowers. In the environs of "Piz Umbrail" and "Quarta Cantoniera," 3,000—2,400 metres above the sea-level, we observed only four humble bees, and not a single individual of any other genus of Apidæ during a sojourn of five days, and in spite of very fine weather, whilst numerous Coleoptera (Dasytes, Anthobium, Anthophagus), many Diptera (especially Muscidæ and Syrphidæ), and very numerous specimens of some species of Lepidoptera were found in the flowers of this region.† Between 2,400 and 2,100 metres (descending towards Bormio and in the environs of Franzenshöh and Trafoi) the number and variety of Apidæ, other Hymenoptera, Coleoptera, and Diptera proved to be much greater; but, at the same time, the number and variety of Lepidoptera increased to such a degree that this order of insects was in unmistakable preponderance also in this region.‡ In the plain, near Lippstadt, on the contrary, and in the lower mountainous region of Sauerland, Thuringia, and Fichtelgebirge, Diptera, but more especially Apidæ, are the most frequent visitors of flowers, although in the latter region a considerable increase in the proportion of Lepidoptera may be remarked.

Consulting our highest authority on the geographical distribution of butterflies in Germany and Switzerland, Dr. Speyer, of Rhoden, I heard that the fact alluded to would be in direct opposition to the general distribution of the species of Lepidoptera in altitude, the number continually decreasing from the lower mountainous to the higher Alpine (subnival) region; only the plain, as it seems, being somewhat poorer. This contradiction, however, may be, and, as I am convinced, from my observations, is, only an apparent one; for, notwithstanding the smaller number of species, the absolute frequency of Lepidopterous individuals, and perhaps also of species, is considerably greater in favourable Alpine localities than in equally large tracts of the lower mountains and of the plain, firstly in consequence of the smaller number of Alpine species distributed over a very restricted area; and secondly, because many of these species are represented in their restricted localities by a surprising number of individuals. Dr. Speyer himself writes me: "I have also myself been frequently struck with the great number, not only of individuals, but also of species, met with in favourable Alpine localities." Moreover, the relative frequency of butterflies, which alone is concerned in estimating their importance in the fertilisation of flowers, seems to be still greater than their absolute frequency in the higher Alpine (subnival) region; insects of other orders, with exception of the Diptera, apparently decreasing in a still larger ratio towards the snow-line. In order to appreciate adequately the differences of frequency alluded to and the share taken by butterflies in fertilising flowers in different regions, it would be necessary to ascertain the exact number of *individuals* of Lepidoptera and of other insects that visit certain flowers of the different regions in a given time. Unfortunately I have neglected such observations, and can only give some statistical data as to the number of *species* of Lepidoptera and other insects observed by myself to visit flowers in different regions. These data can afford but an approximate idea of the above differences, but they will, I hope, sufficiently show that these differences are by no means a product of my imagination, but a matter of fact, and that in Alpine regions Lepidoptera are really of considerably greater importance in relation to the fertilisation of flowers than in the plains.

There are some few species of flowers which I have had the opportunity of observing as to their visitors both in the plain or in the lower mountainous and in the Alpine region; these, of course, will be the most useful for comparison. For the sake of a more easy survey of the statistical notes I shall make use of the following abbreviations: *a* = in the plain, near Lippstadt; *b* = in the lower mountainous region of Sauerland, Thuringia, Fichtelgebirge; *c* = in the Alpine region, near Trafoi, Franzenshöh, Quarta Cantoniera; *Ap.* = Apidæ; *Lep.* = Lepidoptera; *O.I.* = other insects.

The following is a list of the visitors to different plants, so far as I have observed.

1. *Helianthemum vulgare* :—

b. Ap. 5, Lep. 1, O.I. 16 species; Ap. 23, Lep.* 5, O.I. 72 per cent.
c.† ,, 1, ,, 7, ,, 3 ,, ,, 9, ,, 64, ,, 27 ,,

2. *Lotus corniculatus* :—

a. Ap. 19, Lep. 5, O.I. 2 species; Ap. 73, Lep. 19, O.I. 8 per cent.
b. ,, 17, ,, 7, ,, 2 ,, ,, 65, ,, 27, ,, 8 ,,
c. ,, 2, ,, 4, ,, 0 ,, ,, 33, ,, 66, ,, 0 ,,

3. *Prunella vulgaris* :—

a. Ap. 8, Lep. 4, O.I. 0 species; Ap. 66, Lep. 33, O I. 0 per cent.
b. ,, 4, ,, 2, ,, 0 ,, ,, 66, ,, 33, ,, 0 ,,
c. ,, 1, ,, 4, ,, 1 ,, ,, 17, ,, 67, ,, 17 ,,

* It should be noticed that as the flowers of *Helianthemum vulgare* do not secrete honey, Lepidoptera must either obtain a little of the juices of the flowers by boring, or are altogether deceived.

† In the Alpine region my observations have been made on the *var.* grandiflorum.

* Continued from vol. x. p. 130.

† Rhopalocera: *Pieris callidice* Esp., *Lycaena orbitulus* Prunn., *L. semiargus* Rott., *Melitæa merope* Prunn., *M. parthenie* Bkh. var. varia. M.D., *Argynnis pales* W.V., *Erebia tyndarus* Esp. Geometræ: *Psodos alpinata* Scop., *Pygmæna fusca* Thbg. Crambina: *Hercyna schrankiana* Hoch. (*Holosericalis* H.), *H. phrygialis* H., *H. rupestralis* H., *Crambus luctiferellus* H.—according to Dr. Speyer's determination.

‡ We found here Rhopalocera 33, Sphingidæ 4, Bombyces 5, Noctuæ 3, Geometræ 3, Crambina 6, Tineina 2, Pterophorina 1, altogether 57 species of Lepidoptera visiting flowers.

4. *Thymus serpyllum* :—

a. Ap. 7, Lep. 5, O.I. 17 species ; Ap. 24, Lep. 17, O.I. 58 per cent.
b. ,, 5, ,, 17, ,, 23 ,, ,, 11, ,, 38, ,, 51 ,,
c. ,, 2, ,, 17, ,, 0 ,, ,, 10, ,, 89, ,, 0 ,,

5. *Taraxacum officinale* :—

a. Ap. 58, Lep. 7, O.I. 28 species ; Ap. 62, Lep. 7. O.I. 30 per cent.
c. ,, 0, ,, 2, ,, 1 ,, ,, 0, ,, 66, ,, 33 ,,

6. *Valeriana officinalis* :—

a. Ap. 3, Lep. 0, O.I. 19 species ; Ap 14, Lep. 0, O.I. 86 per cent.
c. ,, 3, ,, 2, ,, 2 ,, ,, 43. ,, 28, ,, 28 ,,

All these species show evidently the predominant part which Lepidoptera play as visitors of flowers in the Alpine region. The same result is arrived at by comparing sister-species or sister-genera of flowers, provided with nearly the same contrivances and growing one or some of them in the Alpine region, another or some others in the lower mountainous region, or in the plain.

7. *Geranium pratense* (a, b), and *sylvaticum* (c) :—

a. Ap. 9, Lep. 0, O.I. 1 species ; Ap. 90, Lep. 0, O.I. 10 per cent.
b. ,, 13, ,, 1, ,, 3 ,, ,, 76, ,, 6, ,, 18 ,,
c. ,, 3, ,, 8, ,, 3 ,, ,, 21, ,, 57, ,, 21 ,,

8. *Veronica chamædrys* (a), and *saxatilis* (c) :—

a. Ap. 5, Lep. 1, O.I. 7 species ; Ap. 38, Lep. 8, O.I. 54 per cent.
c. ,, 0, ,, 4, ,, 3 ,, ,, 0, ,, 57, ,, 43 ,,

9. *Jasione montana* (a), and *Phyteuma michelii* (c) :—

a. Ap. 47, Lep. 7, O.I. 47 species ; Ap. 47, Lep. 7, O.I. 47 per cent.
c. ,, 7, ,, 13, ,, 4 ,, ,, 29, ,, 54, ,, 16 ,,

10. *Carduus crispus* (a), *acanthoides* (b), and *defloratus* (c) :—

a. Ap. 9, Lep. 3, O.I. 3 species ; Ap. 60, Lep. 20, O.I. 20 per cent.
b. ,, 32, ,, 5, ,, 9 ,, ,, 70, ,, 11, ,, 19 ,,
c. ,, 4, ,, 8, ,, 7 ,, ,, 21, ,, 42, ,, 37 ,,

11. *Chrysanthemum leucanthemum* (a), *corymbosum* (b), and *alpinum* (c) :—

a. Ap. 12, Lep. 8, O.I. 49 species ; Ap. 17, Lep. 12, O.I. 71 per cent.
b. ,, 3, ,, 3, ,, 18 ,, ,, 12½, ,, 12½, ,, 75 ,,
c. ,, 0, ,, 4, ,, 5 ,, ,, 0, ,, 44 ,, 55 ,,

12. *Senecio Jacobæa* (a), *nemorensis* (b), *abrotanifolius*, *Doronicum* and *nebrodensis* (c) :—

a. Ap. 15, Lep. 2. O.I. 19 species ; Ap. 42, Lep. 5, O.I 53 per cent.
b. ,, 7, ,, 8, ,, 2 ,, ,, 41 ,, 47, ,, 12 ,,
c. ,, 1, ,, 20, ,, 14 ,, ,, 3, ,, 57, ,, 40 ,,

The predominant part played by Lepidoptera in the Alpine region would doubtless appear considerably less striking if the more southern or eastern districts of Germany had been compared with the Alps ; for, according to Dr. Speyer,* the number of species of Lepidoptera continually increases in Germany from the north southwards, and from the west eastwards, to such an extent that, for instance, the number of species of diurnal butterflies (Rhopalocera) amounts, near Hamburg, to 72, near Dantzig to 89, near Freiburg (Baden) to 102, and near Vienna to 130. Hence Lippstadt, in consequence of its north-west situation, ranges among the poorest localities of Germany with respect to butterflies ; and the environs of Vienna would possibly have afforded nearly double the number of Lepidoptera as visitors of the above-named flowers. But if even in *a* and *b* of the above statistical notes the number of Lepidoptera be doubled, in all cases, with the sole exception of *Senecio nemorensis*, the Alpine region would retain a decided preponderance as regards the frequency of butterflies that visit flowers, and even *Senecio nemorensis* is not an exception to the general rule, as my observations on this species have not been made near Lippstadt, but in the "Waldstein," one of the summits of the "Fichtelgebirge."

Hence, though further observations may be necessary, I cannot doubt that the increasing proportion of Lepidoptera which visit flowers in the higher Alpine region will hold good, even after the most extensive and thorough examination of the whole of Germany. Some peculiarities of the Alpine flora to be discussed in my next article, will, I hope, confirm this opinion.

HERMANN MÜLLER

* Die geographische Verbreitung der Schmetterlinge Deutschlands und der Schweitz. Von Dr. Adolph Speyer und August Speyer. Leipzig, 1858, p. 29.

THE CHEMISTRY OF CREMATION

IN a paper recently published in a German periodical,* on the chemical bearings of cremation, Prof. Mohr calls attention to a point which, so far as we know, has not yet been considered.

He remarks that, in the first place, it is necessary that the combustion of the body should be *complete*. Anything of the nature of distillation gives rise to the production of fetid oils, such as were produced when in early times dead horses were distilled for the manufacture of sal-ammoniac. Such a revolting process is surely not compensated by the small commercial value of the products obtained. To effect complete combustion we must have a temperature such that the destruction is final, nothing remaining but carbonic acid, water, nitrogen, and ash ; for which purpose a complicated apparatus consuming large quantities of fuel will be necessary. The gases produced can only be destroyed by being passed through red-hot tubes to which excess of atmospheric air can gain access.

On comparing the substances produced by such a total decomposition of the body with those produced in the ordinary course of subterranean decay, it will be seen that one compound is totally lost by burning —the ammonia which results from the decomposition of the nitrogenous tissues. This ammonia, escaping into the air or being washed into the soil, is ultimately assimilated by plants—goes to the formation of nitrogenous materials, and thus again becomes available for animals. In the ordinary course of nature a continuous circulation of ammonia between the animal and vegetable kingdoms is thus kept up : if we stop one source of supply of this substance, we destroy the equilibrium—we draw upon the ammoniacal capital of the globe, and in the course of time this loss cannot but react upon animal life, a smaller amount of which will then be possible. There is no compensating process going on in nature as is the case with the removal of atmospheric oxygen by breathing animals—we deduct from a finite quantity, and the descendants of present races will, in time to come, have to bear the sin of our shortsightedness, just as we have had to suffer through the shortsightedness of our ancestors, who destroyed ruthlessly vast tracts of forests, thereby incurring drought in some regions and causing destructive inundations in others.

Another loss of ammonia is entailed by civilisation in the use of gunpowder. Nitre results from the oxidation of ammonia, and is a source of nitrogenous compounds to plants, which again reduce the nitrogen to a form available for ammonia. The nitrogen liberated by the explosion of gunpowder adds to the immense capital of the atmosphere, but is no more available for the formation of plants. Every waste charge of powder fired represents a certain loss of life-sustaining material against which the economy of nature protests. The same is to be said of nitro-glycerine, gun-cotton, &c., which contain nitrogen introduced by the action of nitric acid.

Wood and coal are other illustrations of finite capital. Every pound of these substances burnt in waste—consumed, that is, without being made to do its equivalent of work—is a dead loss of force-producing material, for which our descendants will in the far-distant future have to suffer. The changes brought about by the cessation of one large supply of ammonia may be compared with geological changes which, though of extreme slowness, produce vast changes in the lapse of ages. R. M.

A NEW MATERIAL FOR PAPER

THE grass known as Canada Rice (*Zizania aquatica*, Lin., *Hydropyrum esculentum*, Link) is well known to American botanists as a cereal. Linnæus names it, as long ago as 1750, in his "Philosophia Botanica," under the

* *Dahe'm* No. 44.